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A WORLD COMPOSITE CROSS OF BARLEY[1]

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The composite cross of barley, as described and used by Harlan et al.,[3] has led to the release and use of a number of commercial varieties. The result obtained has stimulated other workers to extend this method on a larger scale with improved techniques.

The principal factors making it possible to enlarge this type of cross are the use of a gene for male sterility, a bulk seed lot of the world collection of barleys, and an environment favorable for the production of natural crosses between male sterile plants and pollen from fertile plants. Such a composite cross using a worldwide germplasm base has been made, and seed now is available to plant breeders.

The crossing task was carried out at the University Farm, Davis, Calif., during 1959. The female parent consisted of a number of male sterile stocks that had been developed in the barley breeding project at Davis over a period of years. These stocks, carrying various genetic backgrounds, were established by various breeding procedures, including simple and compound crosses and backcrosses. The basic germplasm of approximately 50 introductions from world sources is represented in this male sterile stock. This stock was developed for California conditions, and for this reason its characteristics are predominantly those commonly associated with a "coast type" barley, although Hannchen and Manchuria types also are represented. In general terms, "coast type" barleys are of the spring habit of growth, early maturing, and nonshattering. They possess erect spikes that are short to midlong with large kernels and are adapted to an arid climate.

The male parent consisted of a mixture of 8 to 10 seeds each from 6,200 spring varieties of the World Collection as maintained by the United States Department of Agriculture.

For crossing purposes segregating male sterile stocks (female parent) and the World Collection bulk (male parent) were sown in alternate rows. Prior to flowering, the female rows were rogued daily to eliminate all male fertile plants. Approximately 100 hours' labor was used in this way. The flowering time of the two parents overlapped during a period of 25 days, thus giving time for all cross-pollinations except from the very early males to occur. These were outcrossed manually.

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[3] Harlan, H. V., Martini, M. L., and Stevens, H. 1940. A study of methods in barley breeding. U. S. Dept. Agr. Tech. Bul. 720, 26 pp.

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The 1959 season at Davis was a relatively poor one for natural pollen dispersal. The seed set on male sterile plants was 19 percent, and a total of 29 pounds of crossed seed was obtained. It is estimated that a total of 2,300 different female and 5,200 different male stocks were crossed.

In 1960, the crossed seed was sown on 4/10 acre and produced 700 pounds, or an estimated 7×10^6 F_1 seeds, no two of which are exactly alike. This F_1 seed now is available to barley breeders throughout the world in small lots of 2 to 4 pounds. Seed requests should be sent to Dr. J. C. Craddock, Crops Research Division, A.R.S., U. S. D. A., Plant Industry Station, Beltsville, Maryland.

When such seed is received, the recipient will first grow this composite cross in the F_2 generation. One-fourth of the plants will be male sterile and thus another round of natural crossing can occur. Thereafter, natural forces will eliminate the male sterile gene in 10 to 15 generations, depending upon how favorable the environment is for natural crossing. Breeders can alter the frequency of this gene by appropriate selection methods. The number of recombinants that can occur from the initial cross of so broad a parental base and from recurrent opportunities for crossing due to the appearance of male sterile plants in the F_2 and succeeding generations is very large indeed. Unfortunately, only a small portion of this total can ever be realized due to the limitations of land, labor, and cost.

This composite cross holds valuable potentials for all spring barley growing areas of the world because of its worldwide germplasm base. It should be of particular interest to those areas or locations where barley is grown, but funds and facilities are lacking for a more conventional breeding program. The composite cross described here can be grown in bulk at such locations for a number of generations with very little time and expense. It is, in fact, a new concept for managing and using the World Collection gene pool.

The results obtained from studies with composite crosses and with mechanical mixtures of varieties by Harlan, Martini, Stevens, Suneson, Wiebe,[4] and others include the following general conclusions that also apply to the composite cross discussed here:

- Natural selection, if allowed to operate on a bulk population for a sufficient number of generations at a single location, will tend to favor and preserve types that are well adapted to that location.
- The types that come into dominance in the bulk population may not always be the highest yielding ones when grown in pure stands.
- The yield of bulk populations tends to increase each generation and follows a sigmoid curve.
- Large bulk populations, like the present one, will favor true natural selection over chance shifts due to small numbers.
- It can be expected that certain genetic characters will be eliminated more rapidly than others and that this change will differ for different environments. Some characters that have been observed to act in this manner are 6-row vs. 2-row, hood vs. awn, rough-awns vs. smooth-awns, and black vs. white kernels.

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[4] Harlan, H. V., and Martini, M. L. 1938. The effect of natural selection in a mixture of barley varieties. Jour. Agr. Res. 57: 189-200.

See also Footnote 2.

Suneson, C. A., and Wiebe, G. A. 1942. Survival of barley and wheat varieties in mixtures. Jour. Amer. Soc. Agron. 34: 1052-1056.

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